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Speed control of Two Induction Motors Fed by Four-Leg Inverter using Fuzzy controller

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Abstract— **This paper shows the speed control of two induction motor fed by four leg inverter(FLI) using fuzzy controller. By using FLI we can drive two induction motor independently. Due to this overall cost of the system is reduced and inverter switching losses also reduced. FLI consists of four leg and two capacitor connected in series. The U and V phase of induction motor 1 is connected to the inverter leg1 and leg2. S imilarly the U and V phase of induction motor2 is connected to the inverter leg3 and leg4. The W phase of both induction motor is shared and connected to neural point potential of two spirit capacitors. The pulse width modulation technique (PWM) is not directly applicable for FLI Because only two phases must be modulated. The fuzzy controller is used to control the speed of induction motors. The reason to select the fuzzy controller is because of easy computation and high accuracy. The fuzzy rule based controller is designed using MATLAB/S IMULINK software.**

Keywords- **four leg inverter, PWM technique, fuzzy controller**

I. INTRODUCTION

The three leg inverter is most commonly used inverter which is used to drive AC motors. But by using three leg inverter we cannot drive two or more alternative current (AC) motors. Recently a single inverter is used to drive two AC motors independently for reducing overall cost, saving space and reduction of inverter losses. For example four-leg, five-leg inverter and six leg inverter. The five-leg inverter is same as that of four leg inverter. In the five-leg inverter, the W phase of both motors is connected to the fifth leg of inverter. Therefore switching losses in this leg is increased compared with other legs. So that the four leg inverter uses capacitor instead of switching devices to solve this problem.

Four leg inverter is a single inverter which is used to drive two induction motors independently. The four leg inverter consists of four leg and two capacitors connected in series. The U and V phase of induction motor1 is connected to inverter leg1 and leg2. Similarly U and V phase of induction motor2 is connected to inverter leg3 and leg4. The W phase of both motors is shared and connected to neutral point of two sprit capacitors.

The speed of induction motor can be controlled by using either scalar control or vector control methods. In this work scalar control methods are used. The scalar control methods are classified as stator voltage control, frequency control, stator voltage and frequency control(v/f control),rotor voltage control. The most popular method of scalar control is v/f control. In this work v/f control is used. In this work fuzzy controller is used to control the speed of two induction motor independently because of its easy computation and high accuracy. Here a rule based fuzzy logic controller is designed using MATLAB/SIMULINK. Christo Ananth et al.[4] presented a brief outline on Electronic Devices and Circuits which forms the basis of the project.

II.MAIN CIRCUIT OF FOUR LEG INVERTER

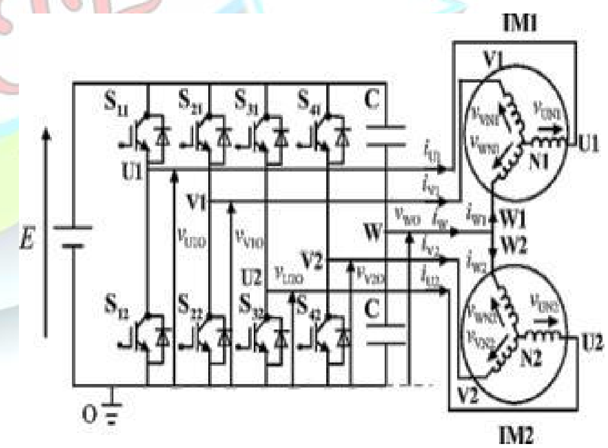

Fig. 1. Main circuit of four-leg inverter

Figure 1 shows the structure of four-leg inverter to supply two three phase induction motors [5]. The inverter consists of four legs and capacitor connected in series. The U and V phases of induction motor1 are connected to inverter U1 and V1 phases. The W phases of both induction motors are connected to neutral point of two-sprit capacitors in common. Where, V_{UNi}, V_{VNi}, V_{WNi} are phase voltages in the IM i(i = 1,2). V_{xO}(x = U1,V1, U2, V2, W) is inverter x phase voltage. V_{WO} indicates the neutral

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point potential of two sprit capacitors. I_{ui}, i_{Vi},i_{Wi} are phase current in the IM i and i_W is inverter phase

The inverter W phase is connected to the neutral point of two-sprit capacitor. So the modulation in the W phase is impossible. The FLI must be modulated only two phase U and V. Due to this the PWM technique is not directly applicable for FLI. The balanced three phase current is obtained by modulating only U and V phases. The U and V phase voltage command of inverter in the IM I can be expressed as follows

current. E express the magnitude of DC-bus voltage. C is capacitance of two-sprit capacitors.

III. PWM T ECCHNIQUE

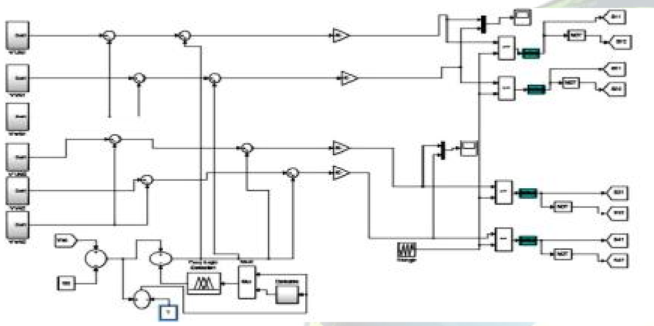

Fig. 2. Block diagram of carrier-based PWM with fuzzy controller

$$V^*_{Ui} = V^*_{UNi} - V^*_{WNi}$$
$$V^*_{Vi} = V^*_{VNi} - V^*_{WNi} \quad (1)$$

Where V^*_{ki} is inverter k phase voltage command in the IM i, "*" is the command value. V^*_{kNi} can be defined as follows

$$V^*_{UNi} = \frac{1}{2} M^*_i E^* \sin(\omega_i^* t - \varphi_i^*)$$
$$V^*_{VNi} = \frac{1}{2} M^*_i E^* \sin(\omega_i^* t - \frac{2\pi}{3} - \varphi_i^*) \quad (2)$$
$$V^*_{WNi} = \frac{1}{2} M^*_i E^* \sin(\omega_i^* t - \frac{4\pi}{3} - \varphi_i^*)$$

Where M^*_i and ω_i^* are modulation index and fundamental angular frequency in IM i respectively. φ_i^* is initial phase angular of phase voltage in the IM i.

The neutral point potential of two-sprit capacitors v_{wo} is given by following equation

$$V^*_{wo} = \frac{1}{2}E - \frac{1}{2C}\int(iw1 + iw2)dt = \frac{1}{2}E + \Delta V_{wo} \quad (3)$$

Where, V_{wo} is fluctuated components of V_{wo}.

From (3), V_{wo} changes around E/2. Because the W phase currents of each motors flow through capacitors. The fluctuation of voltage will affects the motor phase currents. The ΔV_{WO} depends on the fundamental wave frequency. To obtain the balanced three phase current it is necessary to consider compensation method.

The fluctuation of two-sprit capacitor from (3), the balanced three phase current cannot be obtained. To obtain balanced three phase current , the ΔV_{WO} must be added to the U, V phase terminal voltage[7].

IV. FUZZY LOGIC CONT ROLLER

fuzzy logic is a technique, it act as a human -like thinking into control system. The main purpose of designing fuzzy controller is to take its own decision making like a human being. It takes the decision under uncertain condition. Fuzzy controller consists of fuzzifier, knowledge base, Decision making block and defuzzification.

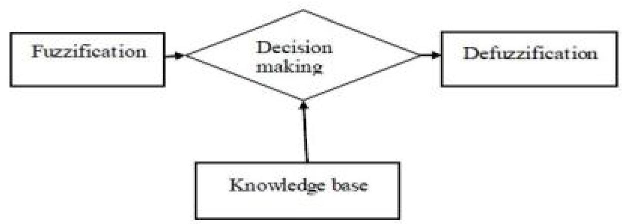

Fig. 3. Fuzzy Block Diagram

The fuzzifier used to converts the numerical value into linguistic variable. In this task, we have to choose proper memberchip function(MF) to converts crisp value into fuzz value. The knowledge base consists of rule base and data base. The data base has the linguistic control rules and th rule bas consists of set of IF-THEN rules. The most important block in the fuzzy controller is desition making block. Based upon inputs it provide output by using database and rule base. The defuzzifier is used to convert the linguistic value into crisp value. It consist of so many methods like centroid of area method, Mean of maxima, largest of maxima. In this work, centroid of area method was used.

steps to design a fuzzy logic controller is as follows

step 1: select the input to FLC
step 2: choose the proper MFs for input and output
step 3: fuzzification process
step 4: Create the fuzzy rules
step 5: choose the proper defuzzification method
step 6: Defuzzification process

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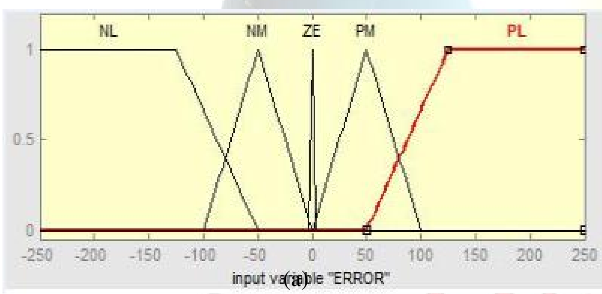
V. FUZZY LOGIC CONT ROLLER DESIGN

For designing the fuzzy logic controller we have to decide what will be the input and we have to select the proper MFs. To design a fuzzy logic controller also we have to select the reference value, proper input and rule base.

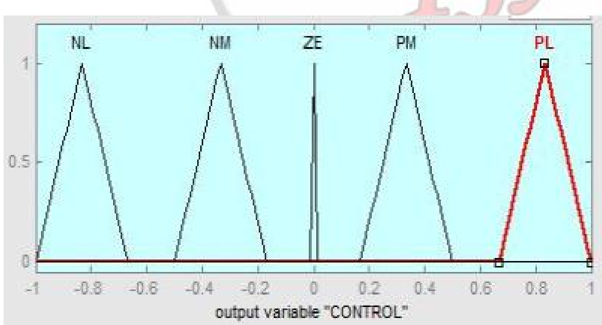
A. Fuzzy rules

In this work seven rules are used to create the control signal for IGBT switches to control the speed of induction motor. The terms used in the rules are Negative large(NL), Negative medium(NM), Zero(ZE), Positive medium(PM), Positive Large(PL). The fuzzy rules are as follows

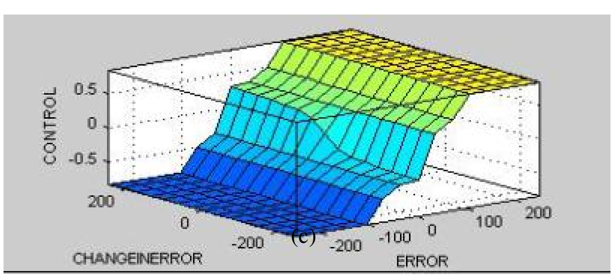
1. IF (Error is PL) THEN (Control is PL)
2. IF (Error is NL) THEN (Control is NL)
3. IF (Error is ZE) AND (Change in error is NL) THEN (Control is NM)
4. IF (Error is ZE) AND (Change in error is PL) THEN (Control is PM)
5. IF (Error is NM) then (Control is NM)
6. IF (Error is PM) THEN (Control is PM)
7. IF (Error is ZE) THEN (Control is ZE)



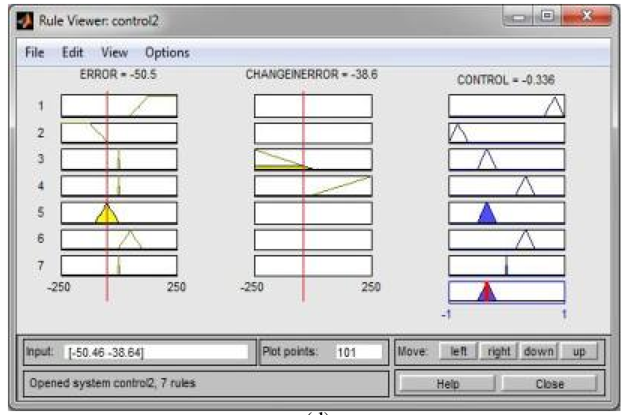
(a)



(b)



(c)



(d)

Fig. 4. (a)Input membership function (b) Output membership function (c) Surface view (d) Rules View

Parameters and rating of the induction motor are as follows: Rated output: 3HP

Rated Voltage: 220volt
Frequency: 50 Hz
Stator Resistance: 3.8Ω
Stator Inductance: 256.6mH
Rotor Resistance: 4.0Ω
Rotor Inductance: 251.0mH
Number of Poles: 4

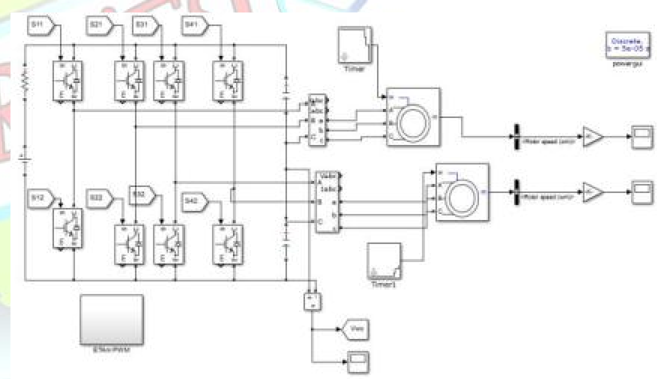


Fig. 5. Speed control of two induction motor in MALAB/SIMULINK

VI. SIMULAT ION RESULT S

Simulation of fig 5 is carried out by using fuzzy controller. Fig 6 is the speed vs time plot for IM1 in clockwise rotation. Fig 7 is the speed vs time plot for IM2 in anticlockwise rotation. From that plot we can conclude that the speed of two induction motors using fuzzy controller can be controlled independently.

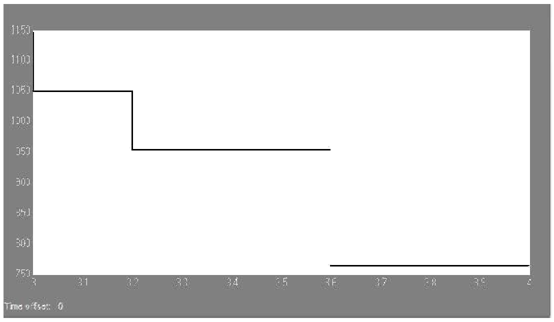


Fig. 6. Speed vs T ime plot of IM1(clockwise rotation)

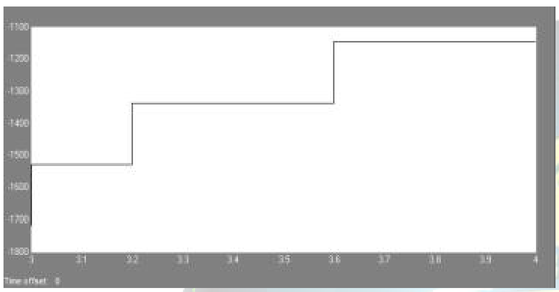


Fig. 7. Speed vs T ime plot of IM2(anticlockwise rotation)

VII. CONCLUSION

The main objective of this project is to control the speed of two induction motor independently using fuzzy controller. The modulation technique for four leg inverter was shown. The rule based fuzzy controller was designed with appropriate membership functions and fuzzy rules. Also the membership functions are slightly tuned at initial process. The simulation results of speed of IM1 and IM2 are shown.

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REFERENCES

[1] Muhammad H. Rashid ―Power Electronic circuits, devices and Applications‖ Second Edition, prentice Hall of India.

[2] George J. Klir and Bo Yuvan ―Fuzzy sets and fuzzy logic‖ published by Prentice Hall PTR.

[3] J. Harris ―Fuzzy logic applications in Engineering Science‖ published by Springer 2006.

[4] Christo Ananth,W.Stalin Jacob,P.Jenifer Darling Rosita. "A Brief Outline On ELECTRONIC DEVICES & CIRCUITS." (2016): 300.

[5] N. Kezuka, K. Oka, and K. Matsuse, ―Characteristics of independent two induction motor fed by a four leg inverter‖, in Proc. IEEE-ECCE Annu. Meeting, Sep.12-16, 2010, pp.2114-21220.

[6] A.Furuya, K. Oka and K. Matsuse, ― A characteristics analysis of four leg inverter in two ac motors drives with independent vector

[7] Yoshinori Katagiri, NobutakaKezuka, Haruki Tanaka, KoukiMatsuse, ―Performance of independent two induction motor drives fed by a four-leg inverter with vector control method,‖ in IEEE, 2011.

[8] P. T ripura and Y.Srinivasa Kishore Babu, "Fuzzy logic speed control of three phase induction motor drive,‖ in world academy of science,engineering and technology, Vol:5 2011 -12-20.

[9] Dhivya Rai, Swathi Sharma, Vijay Bhuria, ― Fuzzy speed controller design of three phase induction motor,‖ in IJETAE Volume 2, Issue 5, May 2012.